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THE RELATION OF MOISTURE TO QUALITY
IN WISCONSIN CHEDDAR CHEESE
BY
LEE JAY SCHENKENBERG

A
THESIS SUBMITTED
FOR THE DEGREE OF MASTER OF SCIENCE

UNIVERSITY OF WISCONSIN
1916

414023
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**THE RELATION OF MOISTURE TO QUALITY
IN WISCONSIN CHEDDAR CHEESE.**

by

Lee Jay Schenkenberg

DEFINITION OF CHEESE. According to the Wisconsin law, "Cheese is a sound, solid, and ripened product made from milk or cream by coagulating the casein thereof with rennet or lactic acid, with or without the addition of ripening ferments or seasoning, and contains in the water-free substance not less than 50% butter fat." By act of Congress the addition of some harmless coloring matter is also permitted.

CHEESE A CONCENTRATED FOOD. Cheese is a very concentrated and economical product when compared with most other foods of either animal or vegetable origin. One pound of cheese contains all the casein and practically all the fat in about ten pounds of milk. Moderately lean meat contains about 73% of water and the rest is proteids and fat, the latter largely predominating. Cheese on the average contains about 37% of moisture and is thus very rich in protein, fat, calcium, and phosphorus. To illustrate the facts, it has been stated that a twenty pound cheese contains as much nourishment as a sheep's carcass of sixty pounds. A pound of cheese contains about two thousand calories of energy, or over three times as much as a pound of meat; yet, at average prices, a pound of cheese can be bought for about one-sixth of the cost of three pounds of meat.

CHEESE IS EASILY DIGESTED. There has been a common belief that cheese is hard to digest. Some people complain of physiological disturbances, as constipation and burning in the stomach when they eat cheese. These disturbances may be due to some of the volatile fatty acids that cheese contains, but is perhaps more often due to the wrong way in which cheese is often eaten, as between meals, or at the close of a meal when the stomach already contains all that it should. Langworthy ¹ conducted a large number of experiments to determine the energy metabolism of cheese and meat by means of the respiration calorimeter, and he found that cheese produced but two calories per hour more than did meat. This small difference might easily be attributed to experimental error. He concluded that there is practically no difference between cheese and meat with respect to ease of digestion, at least not in the quantities usually eaten. In a large number of experiments conducted by the United States Department of Agriculture ² in which cheese was the chief source of protein and energy in the diet, it was found that over 95% of the protein and over 95% of the fat in cheese are digestible, and that 90% of the energy is available for the body. These experiments were conducted on young men in good health. The cheese was supplemented with bread and fruit. The young men did not tire of the diet and showed no physiological disturbances. One young

1. Year Book, U. S. Dep't of Agr. 1910, p. 317.

2. Year Book, U. S. Dep't of Agr. 1910, p. 366.

man for the sake of economy and ease of preparation lived on the above diet for a period of two years without any bad effects. He did not limit the amount of cheese eaten, but governed his diet by his appetite.

INCREASED CONSUMPTION OF CHEESE IS DESIRABLE. In Public Health (London) there are published the results of an investigation to determine the consumption of cheese and meat per capita in Great Britain. It was found that each person consumes annually 10.5 pounds of cheese and 121.8 pounds of meat. In this country, from figures compiled by the Bureau of Statistics of the United States Department of Agriculture, the annual per capita consumption of cheese for 1909 has been computed as about 3.8 pounds, and the per capita consumption for meat ¹ for the same year was 162.2 pounds. With our great increase in population, our western grazing lands are rapidly being converted into grain fields, and the more profitable dairy cow is fast supplanting the beef steer. The price of meat has soared until it is beyond the reach of consumers of moderate means for daily use. As the chief source of protein in the daily diet cheese offers itself as a fit substitute for meat, for cheese may be prepared in a large number of dishes equally as delicious as meat. While economy may compel a greater use of cheese by the poorer classes, there is no reason why everyone should not be urged to a greater use of cheese. Since many people now eat cheese simply as a condiment, for the flavor, it is evident

1. Twenty-Eighth Annual Report of the Bureau of Animal Industry.

that the amount eaten by such consumers is governed almost entirely by the quality of the product. The writer often observed while working in a grocery store, that whenever a good cheese was being sold, the customers would soon return for an additional supply; but when they were supplied with cheese of inferior quality, it might be weeks before they would call for more. It behooves the manufacturer of cheese to produce a better product, and thereby increase the consumption and thus enhance the industry and the profits of those engaged in it.

IMPORTANCE OF THE CHEESE INDUSTRY IN WISCONSIN. Wisconsin is the banner state in the Union in the production of dairy products. The cheese industry is the chief cause for this supremacy. In 1890, Wisconsin was surpassed by New York in the production of cheese, and her product was 21.3% of the nation's output. According to the 1910 Census, Wisconsin produced 147,907,910 pounds of cheese, which was 46% or approximately one-half of the production of the whole nation, and half again as much as New York, her nearest competitor. Wisconsin Cheddar cheese is shipped directly to every state in the Union, and a large amount is exported to foreign countries.

HIGH MOISTURE CHEESE NOT SUITABLE FOR EXPORT. In the beginning of the cheese industry, the product was made almost wholly for the home trade. High moisture cheese was then suitable, because long storage and distant shipments were not necessary. With the later development of the industry, a

large surplus of cheese is made, much of which is stored for considerable periods of time and shipped to other states and foreign countries. The soft home trade cheese is unfit for this purpose. The moisture is not added water, but retained whey. This whey is rich in milk sugar which is converted by bacteria into lactic acid, causing sour or acid cheese. When shipped long distances, such cheese generally reaches its destination in poor condition, giving the purchasers a bad impression of Wisconsin cheese. It is becoming plainly evident that only firm cheese of good quality should be shipped out of the state. It is the duty of those connected with the industry to improve, standardize, and brand their product so as to maintain the reputation of the industry in the state.

EXPERIMENTAL PART. The aim of the following piece of work is to determine the moisture of Wisconsin Cheddar cheese as it occurs in samples received from cheese dealers throughout the state, to get the opinions of the dealers as to the quality of the cheese, and from these data to draw some conclusions as to the upper limit of moisture that Wisconsin cheese may contain without injury to its quality. The sample plugs of cheese were obtained from twenty-three different cheese dealers in the state, in glass jars with cork lined metal caps, in which it could be sent without loss of moisture. Two hundred four teen samples were obtained during the months of February, March, April, and May, 1916. At the laboratory, the samples were cut

into pieces, and ten gram lots were weighed into tared dishes. Whenever the samples were large enough, duplicate determinations were made. These dishes were then placed in a Farrington High Pressure Oven until a constant weight was obtained. This generally took from five to eight hours. From five to ten grams of the samples were also weighed into Babcock cream test bottles for fat tests. The fat determinations were made by adding ten cubic centimeters of distilled water at 140-150° F. to soften the cheese, and then immediately adding 17.5 cubic centimeters of sulphuric acid, specific gravity 1.82. When the cheese was dissolved, the bottles were centrifuged from five to ten minutes, filled to the neck with hot water, shaken, whirled for two minutes, filled up into the graduated portion of the neck, and whirled one or two minutes more. The bottles were then set into water at 140° F. for ten or fifteen minutes, and were read with glymol. In all cases clear fat columns were obtained.

With the aid of the dealers' written opinions, the cheese were classed as, 1. Export cheese, 2. Good cheese for Southern trade, 3. Too moist cheese. Export cheese should be low in moisture, cheese for the South may contain a little more moisture, and too moist cheese is too wet to be shipped or stored.

Forty-one samples were designated by dealers as "export cheese". (See Table I) Their moisture content varied from 34.05 to 40.35%, with an average of 37.08%. Only three

LIST OF DEALERS WHO SUPPLIED
THE SAMPLES OF CHEESE

<u>Name</u>	<u>Address</u>	<u>No. of Samp.</u>
1. Sheboygan Co. Cheese Producers Federation.	Sheboygan, Wis.	54
2. The Zinke Company	Fond du Lac	24
3. N. Simon Cheese Company	Appleton	12
4. Pauley and Bauley	Manitowoc	12
5. Neenah Cheese and Cold Storage Company.	Neenah	6
6. P. H. Peacock	Sheboygan	6
7. John Kirkpatrick	Richland Center	7
8. Winnebago Cheese Company	Fond du Lac	6
9. P. J. Shafer	Marshfield	6
10. Green Bay Cheese Company	Green Bay	6
11. S. J. Stevens Company	Sheboygan	6
12. F. W. Brehm	Sheboygan	6
13. A. D. DeLand	Sheboygan	6
14. J. H. Wheeler	Plymouth	6
15. Dow Cheese Company	Plymouth	6
16. B. W. Rowe	Plymouth	6
17. C. A. Straubel	Green Bay	6
18. Kiel Cheese & Butter Co.	Kiel	6
19. S. H. Conover Cheese Co.	Plymouth	6
20. J. F. Rappel	Manitowoc	6
21. J. L. Jacquot	Appleton	6
22. Roach and Seeber	Waterloo	3
23. A. H. Barber	Chicago, Ill.	6

TABLE I - SHOWING THE PER CENTS OF MOISTURE IN THE CHEESE

<u>Export Cheese</u>	<u>Good Cheese</u>		<u>Too Moist Cheese</u>		
34.05	36.35	38.82	37.15	40.80	42.90
34.20	36.55	38.95	37.50	40.80	42.90
34.40	36.70	38.98	37.75	40.85	42.95
34.53	37.00	39.00	38.15	40.85	43.19
34.90	37.10	39.00	38.50	40.90	43.20
34.92	37.18	39.10	38.52	40.95	43.25
35.35	37.35	39.15	38.60	41.10	43.25
35.45	37.50	39.15	38.90	41.15	43.50
36.10	37.55	39.15	39.30	41.15	43.60
36.20	37.55	39.20	39.45	41.25	43.60
36.25	37.65	39.20	39.50	41.25	43.61
36.45	37.70	39.25	39.60	41.39	43.80
36.65	37.70	39.25	39.60	41.45	43.80
36.70	37.75	39.27	39.69	41.50	43.85
36.70	37.77	39.35	39.70	41.55	44.00
36.75	37.85	39.45	39.70	41.60	44.05
36.95	37.85	39.50	39.85	41.60	44.50
37.15	37.90	39.55	39.85	41.65	44.55
37.20	37.93	39.60	39.90	41.75	44.90
37.25	37.95	39.63	39.95	41.80	45.10
37.30	37.95	39.65	40.00	41.80	48.35
37.32	37.95	39.70	40.00	41.90	<u>48.75</u>
37.35	38.08	39.85	40.00	41.95	
37.45	38.15	40.00	40.00	42.00	
37.60	38.25	40.00	40.00	42.00	
37.72	38.30	40.25	40.00	42.05	
37.75	38.32	40.90	40.00	42.08	
37.80	38.35	<u>41.60</u>	40.10	42.10	
37.90	38.40		40.15	42.10	
37.95	38.40		40.20	42.20	
38.05	38.40		40.25	42.20	
38.15	38.50		40.25	42.30	
38.30	38.50		40.30	42.30	
38.45	38.60		40.40	42.35	
38.45	38.60		40.40	42.40	
38.50	38.65		40.45	42.40	
38.50	38.70		40.50	42.40	
38.75	38.70		40.60	42.43	
39.05	38.70		40.60	42.60	
39.60	38.70		40.65	42.75	
<u>40.35</u>	<u>38.80</u>		<u>40.70</u>	<u>42.85</u>	
Average 37.08% (41 samples)	Average 38.59% (69 samples)		Average 41.45% (104 samples)		

**TABLE II-DISTRIBUTION OF CHEESE AS TO MOISTURE
CONTENT IN EACH CLASS**

	Export grade	Good Cheese for Southern trade	Too moist and soft
Moisture Content	No. of Samples	No. of Samples	no. Samples
34.00-34.99%	6	0	0
35.00-35.99	2	0	0
36.00-36.99	9	3	0
37.00-37.99	13	19	3
38.00-38.99	8	22	5
39.00-39.99	2	20	12
40.00-40.99	1	4	27
41.00-41.99	0	1	17
42.00-42.99	0	0	22
43.00-43.99	0	0	11
44.00-44.99	0	0	5
45.00-45.99	0	0	1
46.00-46.99	0	0	0
47.00-47.99	0	0	0
48.00-48.99	<u>0</u>	<u>0</u>	<u>2</u>
	41	69	104

TABLE III-SHOWING THE PER CENTS OF FAT IN THE CHEESE

Export Cheese	Good Cheese		Too Moist Cheese		
31.11	30.52	32.89	27.24	30.58	32.47
31.22	30.65	32.91	27.98	30.64	32.50
31.77	30.85	32.93	28.03	30.65	32.52
32.33	30.92	32.95	28.08	30.74	32.57
32.49	31.04	32.97	28.54	30.80	32.63
32.79	31.57	33.07	28.85	30.86	32.69
32.97	31.70	33.14	29.18	31.20	32.72
32.98	31.71	33.18	29.25	31.26	32.73
32.99	31.91	33.26	29.28	31.27	32.86
33.02	31.91	33.33	29.37	31.33	33.13
33.48	31.92	33.35	29.55	31.35	33.37
33.54	31.94	33.35	29.60	31.36	33.79
33.57	31.95	33.53	29.62	31.39	33.86
33.58	32.02	33.60	29.65	31.45	33.96
33.61	32.07	33.63	29.73	31.56	34.03
33.75	32.13	33.66	29.80	31.63	34.54
33.91	32.20	33.67	29.97	31.63	34.56
33.93	32.22	33.68	29.98	31.66	35.70
34.01	32.34	33.76	30.00	31.69	<u>35.91</u>
34.10	32.42	33.93	30.08	31.69	
34.19	32.44	34.07	30.13	31.73	
34.22	32.47	34.08	30.16	31.76	
34.23	32.47	34.18	30.17	31.84	
34.32	32.47	34.34	30.21	31.90	
34.36	32.51	34.47	30.23	31.93	
34.41	32.53	34.57	30.23	31.98	
34.57	32.54	35.92	30.38	32.02	
34.60	32.57	<u>36.54</u>	30.40	32.14	
34.77	32.60		30.43	32.16	
35.07	32.76		30.43	32.29	
35.16	32.77		30.43	32.39	
35.90	32.84		30.56	32.44	
<u>35.18</u>	<u>32.88</u>		<u>30.58</u>	<u>32.46</u>	
Average 33 Samples 33.73%	Average 61 Samples 32.85%		Average 85 Samples 31.25%		

TABLE LV-DISTRIBUTION OF CHEESE AS TO FAT CONTENT

IN EACH CLASS

	Export Grade	Good Cheese for Southern trade	Too moist and soft
% Fat in Cheese	No. of Samples	No. of Samples	no. Samp.
27.00-27.99	0	0	2
28.00-28.99	0	0	4
29.00-29.99	0	0	12
30.00-30.99	0	4	21
31.00-31.99	3	9	20
32.00-32.99	6	25	16
33.00-33.99	9	15	5
34.00-34.99	11	5	3
35.00-35.99	3	2	2
36.00-36.99	<u>1</u>	<u>1</u>	<u>0</u>
	33	61	85

samples showed a moisture content of over 39%. From this it is evident that the upper limit of moisture for export cheese should not be over 39%, and 38% may be high enough. Sixty-nine samples designated as "good cheese" varied from 36.35 to 41.60% moisture, and averaged 38.59%. Only five samples showed a moisture content of 40% or above. 40% appears to be altogether too high a moisture content for good cheese. Of one hundred four samples described by dealers as "too moist cheese", the moisture content varied from 37.15 to 48.75%, and averaged 41.45%. Only twenty of the samples showed less than 40% moisture, and only eight had less than 39%. The results show that the dealers generally regard a cheese containing as high as 40% moisture as too soft. Some of these soft samples, when received, lay curled up in the bottom of the sample jars so that one would hardly recognize them as cheese. The making of cheese with 40% moisture, or above is a detriment to the industry, because the dealer necessarily loses by excessive shrinkage and rind rot, because the retail merchant loses from high shrinkage and loss of trade due to sour cheese and other defects, and because the consumer pays for a large amount of matter without nourishment.

THE FAT CONTENT OF CHEESE. Fat determinations were made on only one hundred seventy-nine of the above samples, because part of the samples were large enough for moisture determinations, only. Of this number, thirty-three were classed as export cheese. As shown in Tables III and IV, the fat

content varied from 31.11 to 36.18%, and averaged 33.73%, or slightly over one-third of the weight. Twenty-four or 72.7% of the samples had a fat content of over 33%, and all were above 31%. Of sixty-one samples classified by dealers as good cheese, the variation of fat content was from 30.52 to 36.54%, and averaged 32.85%. Twenty-three, or 37.7% of these samples showed more than 33% fat and fifty-seven or 93.4% had over 31% fat. Of the eighty-five too moist cheese, the fat content varied from 27.24 to 35.91%, and averaged 31.25%. Ten or 11.7% of these samples contained fat over 33% and thirty-nine, or 45.9%, showed fat below 31%. In general the above data shows that the poorer cheese is lowest in per cent of fat.

FAT IN THE DRY MATTER. The laws of Wisconsin do not specify that cheese must contain a certain per cent of fat, but require that not less than 50% of the water-free substance of cheese must be butter fat. In a large number of experiments by the New York Station, this percentage varied from 50.39% to 56.83%. Similar experiments at the Wisconsin Station varied from 51.35% to 56.40%. It is evident that this requirement is a sufficiently high standard to prevent skimming, and even requires skillful manipulation to prevent loss of fat in the making process. The per cent fat in the dry matter in the one hundred seventy-nine samples of this investigation are shown in Tables V, VI, and VII. Only seven of the samples fell below the legal requirement. Two of these were classed as export cheese, one as good cheese, and four as too moist cheese.

TABLE V - SHOWING THE % MOISTURE, % FAT, % FAT IN THE DRY MATTER, AND % MOISTURE IN THE FAT-FREE SUBSTANCE IN EXPORT CHEESE

<u>% Moisture</u>	<u>% Fat</u>	<u>% Fat in D. M.</u>	<u>% Moisture in F-F S.</u>
34.20	32.79	49.84	50.89
34.40	34.41	52.45	52.45
34.53	36.18	55.26	54.12
34.90	34.77	53.41	53.50
34.92	35.16	54.03	53.85
35.45	34.22	53.01	53.89
36.10	34.57	54.10	55.17
36.25	34.60	54.28	55.43
36.45	35.90	56.48	56.86
36.65	33.02	52.12	54.72
36.70	35.07	55.41	56.52
36.75	34.10	53.91	55.77
36.95	31.77	50.45	54.15
37.15	31.11	49.51	53.93
37.20	34.23	54.51	56.56
37.25	33.75	53.79	56.23
37.30	33.61	53.61	56.18
37.35	34.01	54.29	56.60
37.45	33.58	53.70	56.38
37.60	33.91	54.34	57.26
37.72	34.32	55.11	57.43
37.75	31.22	50.15	54.89
37.80	34.36	55.24	57.59
37.90	33.93	54.63	57.36
38.15	32.49	52.54	56.51
38.30	33.48	54.27	57.58
38.45	34.19	55.55	58.43
38.50	32.98	53.62	57.45
38.50	32.99	53.64	57.45
38.75	33.54	54.77	58.31
39.05	33.57	55.07	58.79
39.60	32.33	53.53	58.52
<u>40.35</u>	<u>32.97</u>	<u>55.28</u>	<u>60.20</u>
Average 37.16% (33 samples)	Average 33.73% (33 samples)	Average 53.69% (33 samples)	Average 56.09% (33 samples)

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TABLE VI-SHOWING THE % MOISTURE, % FAT, % FAT IN THE DRY
MATTER, AND % MOISTURE IN THE FAT-FREE SUBSTANCE
IN GOOD CHEESE

<u>% Moisture</u>	<u>% Fat</u>	<u>% Fat in D. m.</u>	<u>% Moisture in F-F. S.</u>
36.35	33.66	52.88	54.81
36.55	33.57	56.06	56.73
36.70	33.60	53.08	55.27
37.00	36.54	58.00	58.30
37.10	34.47	54.91	53.36
37.18	34.07	54.24	56.39
37.35	32.93	52.57	56.99
37.50	33.26	53.21	56.19
37.55	33.18	53.12	56.19
37.55	33.35	53.41	56.34
37.65	33.76	54.14	56.84
37.70	33.07	53.08	56.33
37.75	35.92	57.70	58.91
37.77	33.93	55.79	57.17
37.85	34.08	54.84	57.42
37.85	32.77	52.72	56.30
37.90	30.92	49.80	54.86
37.93	33.53	54.02	57.06
37.95	33.33	53.72	56.92
37.95	33.35	53.75	56.94
37.95	32.47	52.32	56.20
38.08	32.76	52.90	56.63
38.15	33.14	53.59	57.06
38.25	33.63	54.46	57.63
38.32	34.18	55.42	58.22
38.35	33.67	54.62	57.82
38.40	32.34	52.50	56.76
38.40	31.91	51.80	56.40
38.50	32.07	52.14	56.68
38.50	32.95	53.58	57.42
38.60	32.51	52.95	57.19
38.60	32.88	53.55	57.51
38.65	31.95	52.08	56.80
38.70	32.47	52.97	57.31
38.70	32.44	52.92	57.28
38.70	31.94	52.11	56.86
38.70	32.84	53.57	57.62
38.82	32.97	53.89	57.88
38.98	32.89	53.90	58.08
39.00	32.13	52.67	57.46
39.00	32.47	53.24	57.75
39.10	32.22	52.90	57.69

TABLE VI-SHOWING THE % MOISTURE, % FAT, % FAT IN THE DRY MATTER, AND % MOISTURE IN THE FAT-FREE SUBSTANCE IN GOOD CHEESE

<u>% moisture</u>	<u>% Fat</u>	<u>% Fat in D. M.</u>	<u>% Moisture in F-F. S.</u>
39.16	33.68	55.35	59.03
39.16	32.53	53.46	58.03
39.16	31.91	52.44	57.50
39.20	32.91	54.12	58.43
39.25	31.70	52.18	57.47
39.25	31.71	52.20	57.47
39.35	32.20	53.10	58.04
39.50	32.60	53.89	58.61
39.55	32.02	53.01	58.25
39.60	32.57	53.93	58.73
39.63	32.54	53.89	58.74
39.65	34.34	56.90	60.39
39.70	30.85	51.16	57.41
39.85	31.92	53.06	58.53
40.00	31.57	52.65	58.47
40.00	31.04	51.73	58.00
40.25	32.42	54.26	59.56
40.90	30.52	51.64	58.87
<u>41.60</u>	<u>30.65</u>	<u>52.48</u>	<u>59.98</u>
Average 38.56% (61 Samples)	Average 32.85% (61 Samples)	Average 53.48% (61 Samples)	Average 57.39% (61 Samples)

TABLE VII-SHOWING THE % MOISTURE, % FAT IN THE DRY MATTER,
% MOISTURE IN THE FAT-FREE SUBSTANCE IN TOO MOIST CANNES

<u>% Moisture</u>	<u>% Fat</u>	<u>% Fat in D. M.</u>	<u>% Moisture in F-F. S.</u>
37.15	31.90	50.75	54.55
37.75	33.86	54.39	57.08
38.15	36.91	58.05	59.52
38.50	33.96	55.22	59.66
38.52	32.44	52.77	57.02
38.60	34.54	56.25	58.97
38.90	33.79	55.30	58.75
39.30	34.03	56.06	59.57
39.45	32.50	53.67	57.45
39.50	32.73	54.09	58.72
39.60	32.72	54.17	58.86
39.60	32.69	54.12	58.83
39.70	32.86	54.50	59.13
39.85	31.27	51.98	57.98
39.90	30.80	51.01	57.66
39.95	29.62	49.33	56.76
40.00	32.29	53.80	59.08
40.00	31.36	52.26	58.27
40.00	32.57	54.28	59.32
40.00	31.69	52.82	58.56
40.00	32.47	54.12	59.23
40.00	32.14	53.56	58.95
40.10	30.38	50.72	57.60
40.15	32.46	54.23	59.45
40.20	31.73	53.06	58.88
40.25	32.39	54.21	59.53
40.30	33.37	55.90	60.48
40.40	33.13	55.59	60.42
40.40	31.45	52.77	58.93
40.45	31.76	53.74	59.88
40.60	31.35	52.78	59.14
40.60	31.66	53.30	59.41
40.65	32.02	53.94	59.80
40.80	30.56	51.62	58.76
40.85	31.20	52.74	59.39
40.90	30.86	52.22	59.16
40.95	30.58	51.78	58.99
41.10	32.52	55.20	60.91
41.15	31.33	53.23	59.92
41.15	31.63	53.75	60.19
41.25	28.54	48.57	57.73
41.45	31.26	53.39	60.30
41.50	30.64	52.38	59.83
41.55	31.84	54.47	60.96
41.60	31.93	54.67	61.11

TABLE VII-SHOWING THE % MOISTURE, % FAT, % FAT IN THE DRY
MATTER, AND % MOISTURE IN THE FAT-FREE SUBSTANCE IN
100 MOIST CHEESE

<u>Moisture</u>	<u>% Fat</u>	<u>% Fat in D. M.</u>	<u>% moisture in F-F. S.</u>
41.60	31.56	54.04	60.78
41.65	30.13	51.64	59.61
41.75	29.28	50.27	59.04
41.80	29.97	51.50	59.69
41.80	28.85	49.56	58.75
41.90	32.16	55.35	61.76
42.00	31.98	55.14	61.75
42.05	30.74	53.05	60.72
42.08	31.39	54.19	61.33
42.10	29.65	51.21	59.84
42.10	32.63	56.35	62.49
42.20	30.65	53.03	60.85
42.20	29.80	51.56	60.11
42.30	30.43	52.74	60.80
42.30	30.43	52.75	60.80
42.35	30.40	52.73	60.85
42.40	29.37	50.98	60.03
42.40	30.17	52.38	60.72
42.43	30.43	52.71	60.76
42.60	31.63	55.11	62.31
42.75	30.08	52.54	61.14
42.90	29.25	51.23	60.64
42.90	29.98	52.51	61.27
42.95	30.58	51.78	58.99
43.20	31.69	55.80	63.24
43.25	29.73	52.38	61.55
43.25	34.56	60.90	66.09
43.50	30.23	51.67	62.35
43.60	30.21	53.57	62.47
43.60	28.09	50.70	60.63
43.80	30.16	53.54	62.71
43.80	29.55	49.56	58.75
43.85	35.70	63.58	68.20
44.00	30.00	53.57	62.86
44.05	28.03	50.10	60.21
44.50	29.60	53.32	63.21
44.90	29.18	52.96	63.40
45.10	30.23	55.07	64.64
48.35	27.24	52.74	66.45
48.75	27.98	54.60	67.69
Average 41.50% (85 Samples)	Average 31.25% (85 Samples)	Average 53.35% (85 Samples)	Average 60.29% (85 Samples)

TABLE VIII-THE DISTRIBUTION OF CHEESE IN EACH CLASS
AS TO THE PER CENT OF FAT IN THE DRY MATTER

	Export grade	Good Cheese for Southern trade	too moist and soft
% fat in D. M.	No. of Samples	no. of Samples	No. of Samps.
48.00-48.99	0	0	1
49.00-49.99	2	1	3
50.00-50.99	2	0	6
51.00-51.99	0	4	11
52.00-52.99	3	19	18
53.00-53.99	9	21	16
54.00-54.99	9	9	14
55.00-55.99	7	3	10
56.00-56.99	1	2	3
57.00-57.99	0	1	0
58.00-58.99	0	1	1
59.00-59.99	0	0	0
60.00-60.99	0	0	1
63.00-63.99	<u>0</u>	<u>0</u>	<u>1</u>
	33	61	85

The fact that a cheese contains 50% fat in the dry matter does not insure that it is a good quality cheese. One of the very moist samples shown in Table VII contained 43.25% moisture, 34.56% fat, and 60.9% fat in the dry matter which is 10.9% above what the law requires, yet it is a poor cheese. The thirty-three export samples varied from 49.51 to 56.48%, and averaged 53.69%; the sixty-one good samples varied from 49.80 to 58.%, and averaged 53.48%; and the eighty-five too moist samples varied from 48.57 to 60.90%, and averaged 53.35%. The variation among these average figures is exceedingly small and clearly indicates that the per cent of fat in the dry matter is not affected by the moisture content of whole milk cheese.

MOISTURE IN THE FAT-FREE SUBSTANCE. The percentage of moisture in the fat-free substance was also calculated on the one hundred seventy-nine samples. The thirty-three export samples varied from 50.89 to 60.20%, and averaged 56.09%. Only four samples were above 58%, and only one of these was above 60%. The sixty-one good samples varied from 53.36 to 60.39%, and averaged 57.39%. Eighteen of these samples were above 58%, and only one was above 60%. In the eighty-five too moist samples, the variation was from 54.55 to 67.69%, and the average was 60.29%. Only eight of the samples were below 58%, while forty were over 60%. Certainly no good American cheese should contain over 60% moisture in the fat-free material, and the limit might be set at 59%. The relationship of moisture to the matter not fat in cheese is a useful factor in determining

TABLE IX-DISTRIBUTION OF CHEESE OF EACH CLASS AS TO THE PER CENT OF MOISTURE IN THE FAT-FREE SUBSTANCE

% moisture in Fat-Free Substance	Export Grade	Good Cheese for Too moist Southern Grade and soft	
	No. of Samples	No. of Samples	No. Samps.
50.00-50.99	1	0	0
51.00-51.99	0	0	0
52.00-52.99	1	0	0
53.00-53.99	4	1	0
54.00-54.99	4	2	1
55.00-55.99	3	1	0
56.00-56.99	8	18	1
57.00-57.99	7	20	6
58.00-58.99	4	15	16
59.00-59.99	0	3	21
60.00-60.99	1	1	19
61.00-61.99	0	0	7
62.00-62.99	0	0	6
63.00-63.99	0	0	3
64.00-64.99	0	0	1
65.00-65.99	0	0	0
66.00-66.99	0	0	2
67.00-67.99	0	0	1
68.00-68.99	<u>0</u>	<u>0</u>	<u>1</u>
	33	61	85

the quality of cheese.

CAUSES OF SOFT CHEESE. Probably one of the chief causes of soft cheese is that cheesemakers, like most other people, want to get through with their work in a hurry. They do not wait for the proper ripening of the milk in the vat, or the firming of the curd; they heat too soon and too rapidly so a tough layer forms on the cubes preventing the proper expulsion of the whey; and they do not properly mature the curd in the vat before salting. Some cheesemakers, who intentionally work for yield at the expense of quality, are a detriment to the industry and should improve their methods, or be replaced by those who have the welfare of the industry at heart. Dealers should pay a premium for good cheese, and severely cut the price of the inferior product; and the factory patrons should be impressed with the fact that in the long run, it pays to make only good cheese, and should require their cheesemakers to make a better product. Cheesemakers should be familiar with the moisture and fat tests for cheese, and with occasional applications could check their work, and produce a uniform product that would come within the requirements. Cheese dealers should also be familiar with the tests, and should buy and sell cheese with a knowledge of its composition. High moisture cheese should be bought and sold as second grade, and should not be stored long periods, or shipped out of Wisconsin.

NEEDED LEGISLATION CONTROLLING THE MOISTURE

CONTENT OF CHEESE

The results of this investigation show that the moisture content is the greatest factor in determining the quality of Cheddar cheese; and laws should be passed to prevent the making of cheese with excessive moisture. The principal reason for the making of soft cheese intentionally by many factories is to get the same high yield, and to pay the same high price for milk as neighboring factories. Therefore, in order that all factories might begin making good firm cheese at the same time with equal advantage, a date such as, January first, 1917, should be set when a law preventing the manufacture of cheese with excessive moisture would go into effect. The two hundred fourteen analyses here reported, covering a period of four months of the season, are not a sufficient number, and the period of time does not cover enough of the season to allow a final conclusion as to what the law should be; and whether a limit should be set on the per cent of moisture in the fat-free matter. Table II shows that if 40% moisture were the upper limit, then 83, or 80% of the one hundred four too moist cheese would be excluded; Table IX shows that if 59% were the upper limit of moisture in the fat-free substance, then 61, or 71.9% of the eighty-five too moist samples would be outlawed. The investigation will be continued to get further information.

GENERAL SUMMARY

1. Cheese is a very concentrated and economical product, and when one buys cheese he gets the most food for his money.

2. Experiments show that cheese is as easily digested as meat, and may be used as the chief source of protein in the diet. Physiological disturbances noted after eating cheese may be due to incorrect ways in which cheese is often eaten.

3. Cheese is a fit substitute for meat; and a greater use of cheese would result if the quality of the product were improved.

4. Wisconsin produces approximately one-half of the nation's out-put of cheese, and to hold this high place should endeavor to produce only a first class product.

5. High moisture cheese is not suitable for export or long storage.

6. Analyses of samples of export cheese, good cheese, and too moist cheese, based on the estimates of the cheese dealers supplying the samples, show that 37.08% moisture is the average figure for thirty-three export samples, 38.59% for sixty-nine samples of good cheese, and 41.45% for the eighty-five too moist cheese. Only twenty of the too moist samples showed moisture of less than 40%, and only eight had less than 39%. From these figures it is evident that 40% moisture is too high for good cheese.

7. The chief objections to soft cheese are excessive shrinkage, souring in storage, and rind rot.

8. The variation in the fat content of cheese is not so marked in the different classes as the moisture is. Thirty three export samples averaged 33.73%, sixty-one good samples averaged 32.85%, and eighty-five too moist samples averaged 31.25%

9. The per cent of fat in the dry matter is not closely related with the per cent of moisture in the cheese, and does not give a clear idea of the quality. The variation of this percentage in export cheese, good cheese, and too moist cheese is very small, being 53.69%, 53.48% and 53.35% respectively. The value of the Wisconsin law requiring that at least 50% of the dry matter in cheese shall be butter fat lies in the fact that it prevents the skimming of the milk, and even necessitates careful manipulations to prevent loss of fat in the making process in order to meet the requirement.

10. The per cent of moisture in the fat-free substance may be a useful factor in determining the quality of the cheese. The average for thirty-three export samples is 56.09%, for sixty-nine good samples is 57.39%, and for eighty-five too moist samples is 60.29%. Forty of the too moist samples were above 60%, and only eight were below 58%.

11. Cheesemakers and dealers should become familiar with the method of making moisture and fat tests on cheese. They could then be sure that their product is within the limits

adopted.

12. The moisture content is the chief factor in determining the quality of cheese. A law should be passed preventing the making of cheese of excessive moisture. From the data at hand, it is not expedient to come to a final conclusion whether a limit should be set on the per cent of moisture in the cheese, or on the per cent of moisture in the fat-free substance.

Approved J. L. Sammis
Thesis Adviser

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